Wheeler Laboratories, Inc.

A SUBSIDIARY OF HAZELTINE CORPORATION

Box 561, Smithtown, N. Y. 11787

Harold A. Wheeler, President

516 ANdrew 5-3810

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1964 OCT 20

Director, Electronics and Control Division (Code RET)
Office of Advanced Research and Technology
National Aeronautics and Space Administration
Washington, D. C. 20546

Attention: Mr. Roland Chase

Reference: Contract NASw 888.

Subject: Development of Macroscopic Optical Waveguide Components -- Progress 1964 SEP.

Gentlemen:

This is the seventh progress report on the development of macroscopic waveguide components for optical systems being performed for the National Aeronautics and Space Administration (NASA) by Wheeler Laboratories (WL) under contract NASw 888. This report covers the month of September 1964. The overall objectives of the current contract, to be completed by 1964 NOV 28 as described in Ref. 1 are: (1) to determine the factors affecting the design and fabrication of macroscopic waveguide and waveguide components, (2) to investigate specific configurations in order to develop practical concepts for component design, and (3) to undertake actual component fabrication and testing to prove the feasibility of the design concepts.

Work Performed During Current Month.

During the month of September, effort has continued on the second phase of this program which involves the following tasks: (1) a study and performance analysis of component configurations; (2) design, fabrication and testing of certain components.

A. Analysis of Waveguide and Waveguide Components.

An analysis of an optical interference filter constructed in the waveguide medium has been made. Construction in the waveguide removes the ambiguity between spatial and frequency filtering

inherent in such filters operating in free-space. The expected performance of a simple Fabry-Perot filter in waveguide has been computed; experimental verification is planned.

The characteristics of a long slot directional coupler consisting of two bisected waveguides separated by a thin metal wall with a slot have been calculated. A slot of about one centimeter length is required for 3 db coupling between 100 wavelength waveguides.

B. Experimental Testing.

Three quartz slabs (2-1/2 mils thickness) fabricated from Ultrasil quartz were received from Dell Optics Company. This quartz has a reported variation in index of refraction of less than 6×10^{-6}, which should be sufficient for single mode propagation. These slabs will be tested in the next month.

Fixtures for testing waveguide bends and a directional coupler are being fabricated for use with the quartz slabs.

Experimental testing of a waveguide modulator has continued. In the initial testing of the waveguide with nitro-benzene as a liquid core, it was not possible to obtain single mode propagation because of the large difference in index of refraction of the nitro-benzene core and glass cladding. This difference requires an excessively high temperature to nearly equalize the dielectric constants as required for single mode operation. However, electro-optic switching of high order modes has been observed, which indicates the feasibility of this modulation technique.

Other liquids which have a high Kerr constant, and an index of refraction more closely matching that of the glass plates are being obtained.

C. Survey and Study of Waveguide Construction.

A sample of lucite resin was received from Dupont; attempts at casting this material in a thin film are planned.

D. Conferences.

A conference with R. Chase and other NASA personnel from the various space centers is scheduled for OCT 12.

Work Planned for Next Month.

During the month of October, it is planned to continue the experimental evaluation of different types of waveguides and the design, performance analysis and testing of certain components.

(1) Testing of the Ultrasil quartz slabs as waveguide bends and directional couplers is planned.

(2) Calculations of the attenuation of waveguide bends at various operating conditions will be made.

(3) Experimental testing of a section of waveguide in tandem with a Fabry-Perot filter is planned in order to demonstrate the waveguide-filter characteristics.

Personnel.

The work on this project has been carried on by E. R. Schineller, D. W. Wilmot, and H. M. Heinemann under the direct supervision of H. W. Redlien. Advice and general direction has been provided by H. A. Wheeler and F. H. Williams.

References.

(1) D. W. Wilmot, R. A. Kaplan, "Development of Macroscopic Waveguide and Waveguide Components for Optical Systesm", Wheeler Labs. Report 1139; April 1, 1963.

(2) E. R. Schineller, "Development of Macroscopic Optical Waveguide Components -- Progress 1964 February", Technical Letter No. 1 to NASA; 1964 March 17.

(3) H. W. Redlien, "Development of Macroscopic Optical Waveguide Components -- Progress 1964 March", Technical Letter No. 2 to NASA; 1964 April 15.

(4) H. W. Redlien, "Development of Macroscopic Optical Waveguide Components -- Progress 1964 April", Technical Letter No. 3 to NASA; 1964 May 19.

(5) E. R. Schineller, D. W. Wilmot and H. M. Heinemann, "A Macroscopic Waveguide Medium for Laser System Components", Wheeler Labs. Report 1209; June 19, 1964.

(6) E. R. Schineller, "Development of Macroscopic Optical Waveguide Components -- Progress 1964 May-June", Technical Letter No. 4 to NASA; 1964 July 23.

(7) E. R. Schineller, "Development of Macroscopic Optical Waveguide Components -- Progress 1964 July", Technical Letter No. 5 to NASA; 1964 Aug. 24.

(8) E. R. Schineller, "Development of Macroscopic Optical Waveguide Components -- Progress 1964 August", Technical Letter No. 6 to NASA; 1964 SEP 16.

Very truly yours,

E. Ronald Schineller

E. Ronald Schineller
Assistant Project Supervisor

cc: R. H. Chase (1 extra copy)
H. Harrison
Dr. G. Allen Smith
Duncan McIver
Trindel Ferguson
Dr. Max Nagel
Dr. H. H. Plotkin
Dr. Willard H. Wells
E. J. Reinbolt
W. L. Thompson
NASA Representative (14 copies)
Bethesda, Maryland